EARNED VALUE ANALYSIS

A method that is widely used for medium-and high-complexity projects is the earned value management (EVM) method.

EVM is a method of periodically comparing the budgeted costs with the actual costs during the project.

It combines the scheduled activities with detailed cost estimates of each activity. It allows for partial completion of an activity if some of the detailed costs associated with the activity have been paid but others have not.

The budgeted cost of work scheduled (BCWS) comprises the detailed cost estimates for each activity in the project. The amount of work that should have been done by a particular date is the planned value (PV). These terms are used interchangeably by some sources, but the planned value term is used in formulas to refer to the sum of the budgeted cost of work up to a particular point in the project, so we will make that distinction in the definitions in this text for clarity.

Example: PLANNED VALUE ON DAY SIX OF JOHN'S MOVE

On day six of the project, John should have taken his friends to lunch and purchased the packing materials. The portion of the BCWS that should have been done by that date (the planned value) is listed in Figure 9.6. This is the planned value for day six of the project.

Description	Quantity	Cost
Lunch	3	$45.00
Small Boxes	10	$17.00
Medium Boxes	15	$35.25
Large Boxes	7	$21.00
Extra Large Boxes	7	$26.25
Short Hanger Boxes	3	$23.85
Box Tape	2	$7.70
Markers	2	$3.00
Mattress/Spring Bags	2	$5.90
Lift Straps per Pair	1	$24.95
Bubble Wrap	1	$19.95
Furniture Pads	4	$31.80
	Total	$261.65

FIGURE 9.6

PLANNED VALUE FOR LUNCH AND PACKING MATERIALS

Budget At Completion =$1,534

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The budgeted cost of work performed (BCWP) is the budgeted cost of work scheduled that has been done. If you sum the BCWP values up to that point in the project schedule, you have the earned value (EV). The amount spent on an item is often more or less than the estimated amount that was budgeted for that item. The actual cost (AC) is the sum of the amounts actually spent on the items.

COMPARING PV, EV, AND AC IN JOHN'S MOVE ON DAY SIX

Dion and Carlita were both trying to lose weight and just wanted a nice salad. Consequently, the lunch cost less than expected. John makes a stop at a store that sells moving supplies at discount rates. They do not have all the items he needs, but the prices are lower than those quoted by the moving company. They have a very good price on lifting straps so he decides to buy an extra pair.

He returns with some of the items on his list, but this phase of the job is not complete by the end of day six. John bought half of the small boxes, all of five other items, twice as many lifting straps, and none of four other items. John is only six days into his project, and his costs and performance are starting to vary from the plan. Earned value analysis gives us a method for reporting that progress (refer to Figure 9.7).

Project Earned Value Analysis—Day 6

	Budgeted Cost of Work Scheduled (BCWS)		Budgeted Cost of Work Performed (BCWP)		Actual Cost (AC)	
Description	Quantity	Cost	Quantity	Cost	Quantity	Cost
Lunch	3	$45.00	3	$45.00	3	$35.00
Small Boxes	10	$17.00	5	$8.50	5	$9.50
Medium Boxes	15	$35.25	15	$35.25	15	$28.00
Large Boxes	7	$21.00				
Extra Large Boxes	7	$26.25				
Short Hanger Boxes	3	$23.85				
Box Tape	2	$7.70	2	$7.70	2	$5.50
Markers	2	$3.00	2	$3.00	2	$2.00
Mattress/Spring Bags	2	$5.90	2	$5.90	2	$7.50
Lift Straps per Pair	1	$24.95	1	$24.95	2	$38.50
Bubble Wrap	1	$19.95				
Furniture Pads	4	$31.80	4	$31.80	4	$28.50
	PV	$261.65	EV	$162.10	AC	$154.50

FIGURE 9.7 PLANNED VALUE, EARNED VALUE, AND ACTUAL COST

The Spending By Day Six:

PV= $261.65 EV= $162.10 AC= $154.50

SCHEDULE VARIANCE

The project manager must know if the project is on schedule and within the budget. The difference between planned and actual progress is the variance. The schedule variance (SV) is the difference between the earned value (EV) and the planned value (PV). Expressed as a formula, **SV = EV – PV**.

If less value has been earned than was planned, the schedule variance is negative, which means the project is behind schedule.

SCHEDULE VARIANCE ON JOHN'S MOVE

Planning for John's move calls for spending $261.65 by day six, which is the planned value (PV). The difference between the planned value and the earned value is the scheduled variance (SV). In this example,

SV = $162.10 – $261.65 = $(99.55)

A negative SV indicates the project is behind schedule.

COST VARIANCE

The difference between the earned value (EV) and the actual cost (AC) is the cost variance (CV). Expressed as a formula, **CV = EV – AC**.

A positive CV indicates the project is under budget.

COST VARIANCE ON JOHN'S MOVE

The difference between the earned value of $162.10 and the actual cost of $154.50 is the cost variance (CV). In this example,

CV = $162.10 – $154.50 = $7.60

A positive CV indicates the project is under budget.

VARIANCE INDEXES FOR SCHEDULE AND COST

The schedule variance and the cost variance provide the amount by which the spending is behind (or ahead of) schedule and the amount by which a project is exceeding (or less than) its budget. They do not give an idea of how these amounts compare with the total budget.

The ratio of earned value to planned value gives an indication of how much of the project is completed. This ratio is the schedule performance index (SPI). The formula is **SPI = EV/PV**.

A SPI value less than one indicates the project is behind schedule.

VARIANCE INDEXES FOR SCHEDULE AND COST OF JOHN'S MOVE

The SPI equals 0.62 (SPI = $162.10/$261.65 = 0.62)

A SPI value less than one indicates the project is behind schedule.

COST PERFORMANCE INDEX

The ratio of the earned value to the actual cost is the cost performance index (CPI). The formula is **CPI = EV/AC**.

A value greater than 1 indicates the project is under budget.

COST PERFORMANCE INDEX OF JOHN'S MOVE

In the John's move example, CPI = $162.10/$154.50 = 1.05

A value greater than 1 indicates the project is under budget.

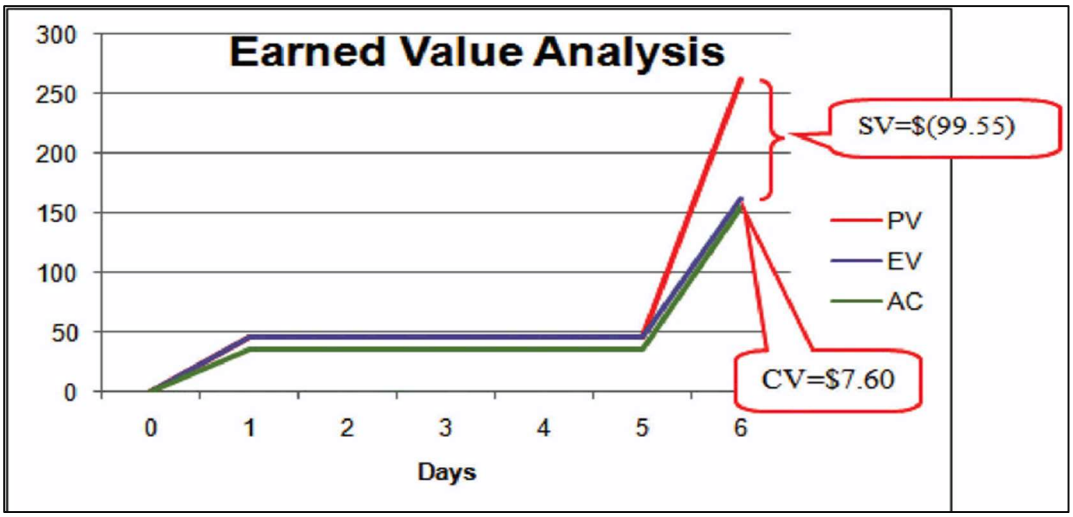


FIGURE 9.8 SCHEDULE VARIANCE AND COST VARIANCE ON DAY SIX OF THE JOHN'S MOVE PROJECT

- The cost variance of positive $7.60 and the CPI value of 1.05 tell John that he is getting more value for his money than planned for the tasks scheduled by day six.
- The schedule variance (SV) of negative $99.55 and the schedule performance index (SPI) of 0.62 tell him that he is behind schedule in adding value to the project.

During the project, the manager can evaluate the schedule using the schedule variance (SV) and the schedule performance index (SPI) and the budget using the cost variance (CV) and the cost performance index (CPI).

ESTIMATED COST TO COMPLETE THE PROJECT

Partway through the project, the manager evaluates the accuracy of the cost estimates for the activities that have taken place and uses that experience to predict how much money it will take to complete the unfinished activities of the project—the estimate to complete (ETC).

To calculate the ETC, the manager must decide if the cost variance observed in the estimates to that point are representative of the future.

For example, if unusually bad weather causes increased cost during the first part of the project, it is not likely to have the same effect on the rest of the project. If the manager decides that the cost variance up to this point in the project is atypical not typical then the estimate to complete is the difference between the original budget

for the entire project-the budget at completion (BAC) and the earned value (EV) up to that point. Expressed as a formula, **ETC = BAC − EV**

ESTIMATE TO COMPLETE JOHN'S MOVE

In John's move, John was able to buy most of the items at a discount house that did not have a complete inventory and, he chose to buy an extra pair of lift straps. He knows that the planned values for packing materials were obtained from the price list at the moving company where he will have to buy the rest of the items, so those two factors are not likely to be typical of the remaining purchases.

The reduced cost of lunch is unrelated to the future costs of packing materials, truck rentals, and hotel fees.

John decides that the factors that caused the variances are atypical. He calculates that the estimate to complete (ETC) is the budget at completion ($1,534) minus the earned value at that point ($162.10), which equals $1,371.90.

Expressed as a formula, (ETC = $1,534 − $162.10 = $1,371.90).

If the manager decides that the cost variance is caused by factors that will affect the remaining activities, such as ***higher labor and material costs***, then the estimate to complete (ETC) needs to be adjusted by dividing it by the cost performance index (CPI).

For example, if labor costs on the first part of a project are estimated at $80,000 (EV) and they actually cost $85,000 (AC), the cost variance will be 0.94. (Recall that the cost variance = EV/AC).

To calculate the estimate to complete (ETC) assuming the cost variance on known activities is typical of future cost, the formula is **ETC = (BAC – EV)/CPI**.

If the budget at completion (BAC) of the project is $800,000, the estimate to complete is ($800,000 – $80,000)/0.94 = $766,000.

ESTIMATE FINAL PROJECT COST

If the costs of the activities up to the present vary from the original estimates, it will affect the total estimate for the project cost. The new estimate of the project cost is the estimate at completion (EAC). To calculate the EAC, the estimate to complete (ETC) is added to the actual cost (AC) of the activities already performed. Expressed as a formula, **EAC = AC + ETC.**

ESTIMATE AT COMPLETION FOR JOHN'S MOVE

The revised estimate at completion (EAC) for John's move at this point in the process is EAC = $154.50 + $1,371.90 = $1,526.40.

Refer to Figure 9.9 for a summary of terms and formulas.

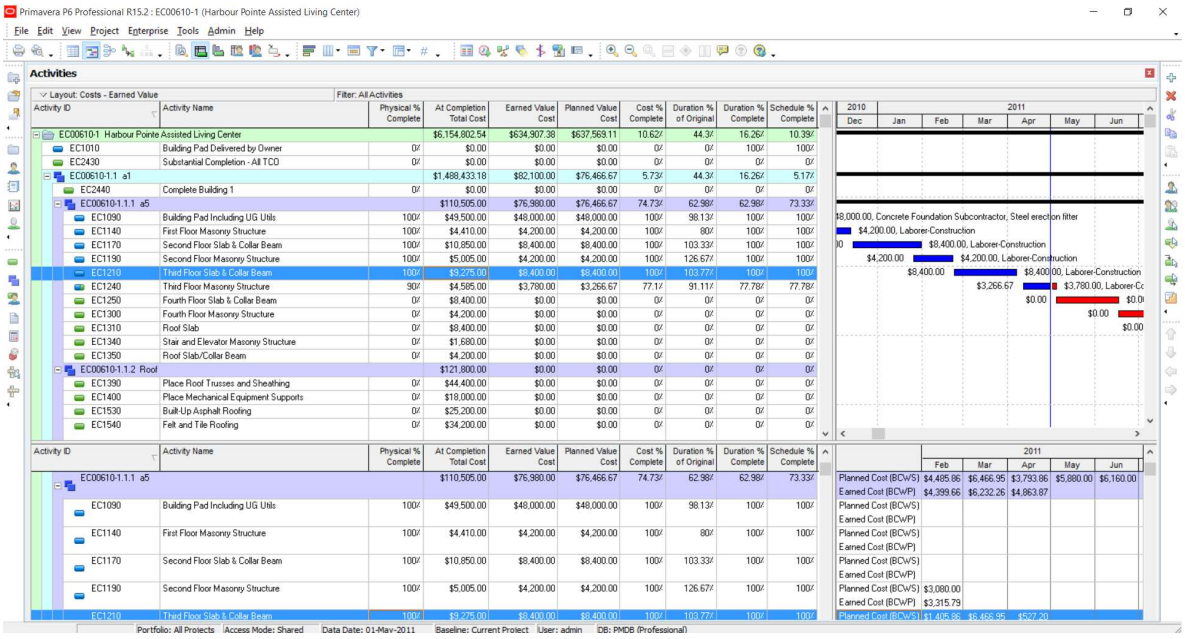
Term	Acronym	Description	Formula	John's Move
Actual Cost	AC	The money actually spent on projects up to the present		$154.50
Budget at Completion	BAC	Original budget for the project (same as BCWS)		$1,534.00
Cost Performance Index	CPI	Ratio of earned value to actual cost	CPI = EV / AC	1.05
Cost Variance	CV	Difference between earned value and actual cost	CV = EV – AC	$ 7.60
Earned Value	EV	Sum of estimates for work actually done up to the present		$162.10
Estimate at Completion	EAC	Revised estimate of total project cost	EAC = AC + ETC	$1,526.40
Estimate to Complete	ETC	Money to complete the project if early cost variance is atypical	ETC = BAC – EV	$1,371.90
Estimate to Complete	ETC	Money to complete the project if early cost variance is typical	ETC = (BAC – EV) / CPI	N/A
Planned Value	PV	Sum of the estimates for work done up to the present		$261.65
Schedule Performance Index	SPI	Ratio of earned value to planned value	SPI = EV / PV	.62
Schedule Variance	SV	Difference between earned value and planned value	SV = EV – PV	$(99.55)

FIGURE 9.9 SUMMARY OF TERMS AND FORMULAS FOR EARNED VALUE ANALYSIS

KEY TAKEAWAYS

- ✓ Extra money is allocated in a contingency fund to deal with activities where costs exceed estimates. Funds are allocated in a management reserves in case a significant opportunity or challenge occurs that requires change of scope but funds are needed immediately before a scope change can typically be negotiated.
- ✓ Schedule variance is the difference between the parts of the budget that has been done so far (EV) versus the part that was planned to be completed by now (PV). Similarly, the cost variance is the difference between the EV and the actual cost (AC).
- ✓ The schedule performance index (SPI) is the ratio of the earned value and the planned value. The cost performance index (CPI) is the ratio of the earned value (EV) to the actual cost (AC).
- ✓ The formula used to calculate the amount of money needed to complete the project (ETC) depends on whether or not the cost variance to this point is expected to continue (typical) or not (atypical). If the cost variance is atypical, the ETC is simply the original total budget (BAC) minus the earned value (EV). If they are typical of future cost variances, the ETC is adjusted by dividing the difference between BAC and EV by the CPI.
- ✓ The final budget is the actual cost (AC) to this point plus the estimate to complete (ETC).

Earned Value in P6



Some benefits of calculating Earned Value in P6 are the ability to calculate activity percent complete and view in graphical form to predict obstacles early in a project schedule; forecasting project progress more effectively; and developing an early understanding of progress according to budget and schedule to identify problems as they arise.

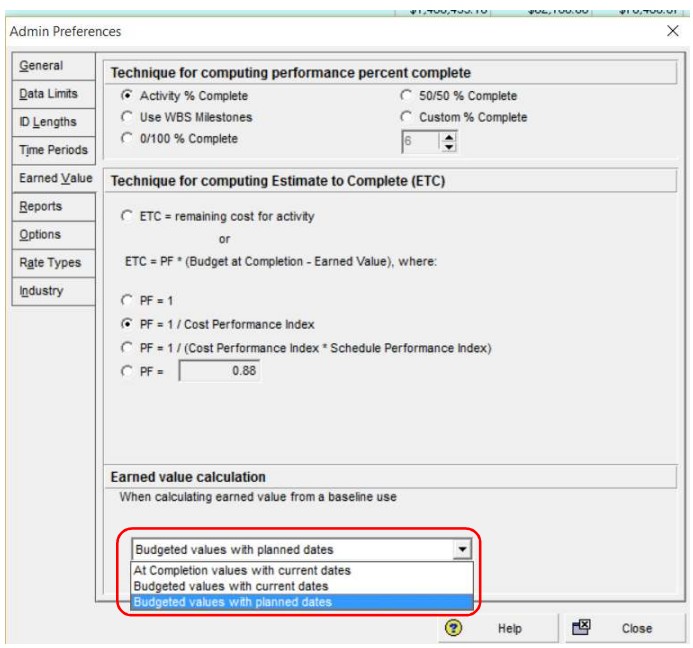
Actual Cost (ACWP)

Actual Cost (ACWP) is the actual total cost incurred on the activity as of the project data date. ACWP is the same as the Actual Total Cost.

✓ ACWP = Actual labor Cost + Actual Non-labor Cost + Actual Material Cost + Actual Expense Cost

Budget At Completion (BAC)

This is always the Total cost from the Baseline, calculated using the Baseline Budgeted Values or Baseline At Completion values depending upon the 'Earned Value Calculation' setting (Admin, Admin Preferences, Earned Value).



If the 'Earned Value Calculation' is set to 'Budgeted Values with Planned dates' or 'Budgeted Values with Current Dates':

✓ **BAC = BL Budgeted Labor Cost + BL Budgeted Non-Labor Cost + BL Budgeted Material Cost + BL Budgeted Expense Cost.**

If the 'Earned Value Calculation' is set to 'At Completion Values with Current Dates':

- ✓ **BAC = BL At Completion Labor Cost + BL At Completion Non-Labor Cost + BL At Completion Material Cost + BL At Completion Expense Cost.**

Cost Performance Index (CPI)

A CPI greater than 1 means that Earned Value is greater than the actual amount spent. A CPI of less than 1 means that the Earned Value is less than the actual amount spent.

- ✓ **CPI = EV / Actual Cost**

Cost Variance (CV)

Cost Variance is the difference between the Earned Value and the actual cost of that activity.

- ✓ **CV = EV – Actual Cost**

Earned Value Cost (BCWP or EV)

Earned Value Cost (EV) is the portion of the budgeted total cost of the activity that is actually completed as of the project data date. Also known as the Budgeted Cost of Work Performed for the activity. The method for computing the performance percent complete depends on the Earned Value technique selected for the activity's WBS.

- ✓ **EV = BAC * Performance % Complete**

Estimate At Completion (EAC)

EAC is the estimated cost at completion for the activity.

- ✓ **EAC = Actual Cost + ETC.**

Estimate to Complete (ETC)

Estimate to Complete is the estimated cost left to complete on the activity. The calculation can be customized at the WBS level (On the 'Earned Value' tab in the WBS view).

It can be computed as either:

- ✓ **ETC = Remaining Total Cost for the activity**
- ✓ **ETC = PF * (BAC – EV)**

Where 'PF' is a multiplier to weight the ETC calculation. This can be either '1', '1/CPI' or '1/(SPI * CPI)' or user defined amount.

Planned Value Cost (BCWS or PV)

Planned Value Cost (PV) is the portion of the budgeted total cost of the activity that is scheduled to be completed as of the project data date according to the baseline dates. Also known as the Budgeted Cost of Work Scheduled for the activity. The Schedule % Complete specifies how much of the activity's original duration has been completed so far based on the baseline dates.

- ✓ **PV = BAC * Schedule % Complete**

Schedule Performance Index (SPI)

A SPI greater than 1 means that Earned Value is greater than the Planned Value. A SPI of less than 1 means that the Earned Value is less than the Planned Value.

- ✓ **SPI = EV / PV**